

## AMENDMENTS TO THE CLAIMS:

This listing of changes will replace all prior versions, and listings, of claims in the specification:

### Listing of Claims:

1. (Currently Amended) A method of manufacturing a silicon single crystal, comprising rotating a quartz crucible (13) for storing a silicon melt (12) at a ~~predetermined~~ rotation speed, rotating a silicon single crystal ingot (25) pulled from the silicon melt (12) in an opposite direction to the rotation of the quartz crucible (13) at a ~~predetermined~~ rotation speed, and pulling the silicon single crystal ingot (25) at a pull rate such that an interior of the silicon single crystal ingot (25) becomes a perfect region in which agglomerates of interstitial silicon-type point defects and agglomerates of vacancy-type point defects are absent:

wherein an average rotation speed  $CR_{TAV}$  of the quartz crucible (13) during the pulling of a top ingot portion (25a) of the silicon single crystal ingot (25) is set faster than an average rotation speed  $CR_{BAV}$  of the quartz crucible (13) during the pulling of a bottom ingot portion (25b) of the silicon single crystal ingot (25).

2. (Original) The method of manufacturing a silicon single crystal according to claim 1, wherein the average rotation speed  $CR_{TAV}$  is set to be within the range of from 5 to 10 rpm, the average rotation speed  $CR_{BAV}$  is set to be within the range of from 3 to 8 rpm, and the difference between the average rotation speed  $CR_{TAV}$  and the average rotation speed  $CR_{BAV}$  is set to be within the range of from 0.1 to 7 rpm.

3. (Currently Amended) A method of manufacturing a silicon single crystal, comprising rotating a quartz crucible (13) for storing a silicon melt (12) at a ~~predetermined~~ rotation speed, rotating a silicon single crystal ingot (25) pulled from the silicon melt (12) in an opposite direction to the rotation of the quartz crucible (13) at a ~~predetermined~~ rotation speed, and pulling the silicon single crystal ingot (25) at

a pull rate such that an interior of the silicon single crystal ingot (25) becomes a perfect region in which agglomerates of interstitial silicon-type point defects and agglomerates of vacancy-type point defects are absent:

wherein a ratio  $SR_{TAV}/CR_{TAV}$  of an average rotation speed  $SR_{TAV}$  of the silicon single crystal ingot (25) and an average rotation speed  $CR_{TAV}$  of the quartz crucible (13) during the pulling of a top ingot portion (25a) of the silicon single crystal ingot (25) is set to be equal to or smaller than a ratio  $SR_{BAV}/CR_{BAV}$  of an average rotation speed  $SR_{BAV}$  of the silicon single crystal ingot (25) and an average rotation speed  $CR_{BAV}$  of the quartz crucible (13) during the pulling of a bottom ingot portion (25b) of the silicon single crystal ingot (25).

4. (Original) The method of manufacturing a silicon single crystal according to claim 3, wherein the ratio  $SR_{TAV}/CR_{TAV}$  is set to be within the range of from 2.0 to 3.6, the ratio  $SR_{BAV}/CR_{BAV}$  is set to be within the range of from 2.0 to 18, and (the ratio  $SR_{TAV}/CR_{TAV}$  – the ratio  $SR_{BAV}/CR_{BAV}$ ) is set to be within the range of from –16 to 0.

5. (Original) The method of manufacturing a silicon single crystal according to claim 1, wherein:

a heat shield member (36) is interposed between an outer circumferential surface of the silicon single crystal ingot (25) pulled from the silicon melt (12) and a heater (13) surrounding the quartz crucible (13);

the heat shield member (36) is positioned above a surface of the silicon melt (12) at a gap and has a cylindrical portion (37) surrounding the outer circumferential surface of the silicon single crystal ingot (25), and a bulging portion (41) provided at a lower portion of the cylindrical portion (37) bulging inwardly of the cylindrical portion and having a heat-storing member (47) in an interior thereof; and

a diameter  $d$  is 100 mm or more where  $d$  is a diameter of the silicon single crystal ingot (25), a height ( $H_1$ ) of an inner circumferential surface of the heat-storing member (47) is 10 to  $d/2$  mm, and a minimum gap ( $W_1$ ) between an inner

circumferential surface of the heat-storing member (47) and the outer circumference of the silicon single crystal ingot (25) is 10 to 0.2d mm.

6. (Original) The method of manufacturing a silicon single crystal according to claim 2, wherein:

a heat shield member (36) is interposed between an outer circumferential surface of the silicon single crystal ingot (25) pulled from the silicon melt (12) and a heater (13) surrounding the quartz crucible (13);

the heat shield member (36) is positioned above a surface of the silicon melt (12) at a gap and has a cylindrical portion (37) surrounding the outer circumferential surface of the silicon single crystal ingot (25), and a bulging portion (41) provided at a lower portion of the cylindrical portion (37) bulging inwardly of the cylindrical portion and having a heat-storing member (47) in an interior thereof; and

a diameter d is 100 mm or more where d is a diameter of the silicon single crystal ingot (25), a height ( $H_1$ ) of an inner circumferential surface of the heat-storing member (47) is 10 to  $d/2$  mm, and a minimum gap ( $W_1$ ) between an inner circumferential surface of the heat-storing member (47) and the outer circumference of the silicon single crystal ingot (25) is 10 to 0.2d mm.

7. (Original) The method of manufacturing a silicon single crystal according to claim 3, wherein:

a heat shield member (36) is interposed between an outer circumferential surface of the silicon single crystal ingot (25) pulled from the silicon melt (12) and a heater (13) surrounding the quartz crucible (13);

the heat shield member (36) is positioned above a surface of the silicon melt (12) at a gap and has a cylindrical portion (37) surrounding the outer circumferential surface of the silicon single crystal ingot (25), and a bulging portion (41) provided at a lower portion of the cylindrical portion (37) bulging inwardly of the cylindrical portion and having a heat-storing member (47) in an interior thereof; and

a diameter d is 100 mm or more where d is a diameter of the silicon single

crystal ingot (25), a height ( $H_1$ ) of an inner circumferential surface of the heat-storing member (47) is 10 to  $d/2$  mm, and a minimum gap ( $W_1$ ) between an inner circumferential surface of the heat-storing member (47) and the outer circumference of the silicon single crystal ingot (25) is 10 to  $0.2d$  mm.

8. (Original) The method of manufacturing a silicon single crystal according to claim 4, wherein:

a heat shield member (36) is interposed between an outer circumferential surface of the silicon single crystal ingot (25) pulled from the silicon melt (12) and a heater (13) surrounding the quartz crucible (13);

the heat shield member (36) is positioned above a surface of the silicon melt (12) at a gap and has a cylindrical portion (37) surrounding the outer circumferential surface of the silicon single crystal ingot (25), and a bulging portion (41) provided at a lower portion of the cylindrical portion (37) bulging inwardly of the cylindrical portion and having a heat-storing member (47) in an interior thereof; and

a diameter  $d$  is 100 mm or more where  $d$  is a diameter of the silicon single crystal ingot (25), a height ( $H_1$ ) of an inner circumferential surface of the heat-storing member (47) is 10 to  $d/2$  mm, and a minimum gap ( $W_1$ ) between an inner circumferential surface of the heat-storing member (47) and the outer circumference of the silicon single crystal ingot (25) is 10 to  $0.2d$  mm.

9. (Original) The method of manufacturing a silicon single crystal according to claim 1, wherein a flow velocity index  $S$  of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index  $S$  being obtained by the following Equation (1):

$$S = (P_o/E) \times F/A \quad (1)$$

where  $P_o$  is an atmospheric pressure (Pa) outside an chamber (11),  $E$  is an internal pressure (Pa) of the chamber (11),  $F$  is a flow rate ( $m^3/\text{second}$ ) of the inert gas supplied to the chamber (11) at the pressure  $P_o$  (Pa) at room temperature, and  $A$  is a cross-sectional area ( $m^2$ ) of a gap between the bulging portion (41) and the silicon

single crystal ingot (25).

10. (Original) The method of manufacturing a silicon single crystal according to claim 2, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index S being obtained by the following Equation (1):

$$S = (P_o/E) \times F/A \quad (1)$$

where  $P_o$  is an atmospheric pressure (Pa) outside an chamber (11), E is an internal pressure (Pa) of the chamber (11), F is a flow rate ( $m^3$ /second) of the inert gas supplied to the chamber (11) at the pressure  $P_o$  (Pa) at room temperature, and A is a cross-sectional area ( $m^2$ ) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

11. (Original) The method of manufacturing a silicon single crystal according to claim 3, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index S being obtained by the following Equation (1):

$$S = (P_o/E) \times F/A \quad (1)$$

where  $P_o$  is an atmospheric pressure (Pa) outside an chamber (11), E is an internal pressure (Pa) of the chamber (11), F is a flow rate ( $m^3$ /second) of the inert gas supplied to the chamber (11) at the pressure  $P_o$  (Pa) at room temperature, and A is a cross-sectional area ( $m^2$ ) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

12. (Original) The method of manufacturing a silicon single crystal according to claim 4, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index S being obtained by the following Equation (1):

$$S = (P_o/E) \times F/A \quad (1)$$

where  $P_o$  is an atmospheric pressure (Pa) outside an chamber (11), E is an internal

pressure (Pa) of the chamber (11), F is a flow rate (m<sup>3</sup>/second) of the inert gas supplied to the chamber (11) at the pressure Po (Pa) at room temperature, and A is a cross-sectional area (m<sup>2</sup>) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

13. (Original) The method of manufacturing a silicon single crystal according to claim 5, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index S being obtained by the following Equation (1):

$$S = (P_o/E) \times F/A \quad (1)$$

where Po is an atmospheric pressure (Pa) outside an chamber (11), E is an internal pressure (Pa) of the chamber (11), F is a flow rate (m<sup>3</sup>/second) of the inert gas supplied to the chamber (11) at the pressure Po (Pa) at room temperature, and A is a cross-sectional area (m<sup>2</sup>) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

14. (Original) The method of manufacturing a silicon single crystal according to claim 6, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index S being obtained by the following Equation (1):

$$S = (P_o/E) \times F/A \quad (1)$$

where Po is an atmospheric pressure (Pa) outside an chamber (11), E is an internal pressure (Pa) of the chamber (11), F is a flow rate (m<sup>3</sup>/second) of the inert gas supplied to the chamber (11) at the pressure Po (Pa) at room temperature, and A is a cross-sectional area (m<sup>2</sup>) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

15. (Original) The method of manufacturing a silicon single crystal according to claim 7, wherein a flow velocity index S of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be

2.4 to 5.0 m/s, the flow velocity index S being obtained by the following Equation (1):

$$S = (P_o/E) \times F/A \quad (1)$$

where  $P_o$  is an atmospheric pressure (Pa) outside an chamber (11),  $E$  is an internal pressure (Pa) of the chamber (11),  $F$  is a flow rate ( $m^3$ /second) of the inert gas supplied to the chamber (11) at the pressure  $P_o$  (Pa) at room temperature, and  $A$  is a cross-sectional area ( $m^2$ ) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

16. (Original) The method of manufacturing a silicon single crystal according to claim 8, wherein a flow velocity index  $S$  of an inert gas that flows down in a gap between the bulging portion (41) and the silicon single crystal ingot (25) is set to be 2.4 to 5.0 m/s, the flow velocity index  $S$  being obtained by the following Equation (1):

$$S = (P_o/E) \times F/A \quad (1)$$

where  $P_o$  is an atmospheric pressure (Pa) outside an chamber (11),  $E$  is an internal pressure (Pa) of the chamber (11),  $F$  is a flow rate ( $m^3$ /second) of the inert gas supplied to the chamber (11) at the pressure  $P_o$  (Pa) at room temperature, and  $A$  is a cross-sectional area ( $m^2$ ) of a gap between the bulging portion (41) and the silicon single crystal ingot (25).

17. (Previously Presented) A silicon single crystal manufactured by a method according to claim 1.

18. (Previously Presented) A silicon single crystal manufactured by a method according to claim 3.